

with the author's sincere regards

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ART. LVII. *On the structure of the Beak and its muscles in the Crossbill, (Loxia curvirostra.)* By WILLIAM YARRELL, Esq., F.L.S., &c.

THE peculiar formation and direction of the parts of the beak in the Crossbill, its anomalous appearance, as well as the particular and powerful manner in which it is exercised, had long excited in me a desire to examine the structure of an organ so curious; and the kindness of a friend has lately supplied me with an opportunity.

To those who have not made the habits and economy of birds an object of investigation, it may be necessary to state that our two species of Crossbill are the only British birds that exhibit or seem to require any lateral motion of the mandibles, and it is the object of this paper to describe the bony structure and muscles by which this peculiar and powerful action is obtained.

It may be necessary to premise that Mr. Townson in his "Observations in Natural History and Physiology," has devoted a chapter to the structure of the bill of the Crossbeak, some extracts from which will be introduced in this notice; but to show that I am not occupying the valuable pages of the Journal with a tale twice told, the first sentence I select is as follows. Speaking of the beak, he says, "I ought now to give the anatomy of it, and I wish it were in my power; but on the muscles, by which the motions I have spoken of are performed, I find scarce any memorandums in my portfolio."

The beak of the Crossbill is altogether unique in its form; the mandibles do not lye upon each other with their lateral edges in opposition as in other birds, but curve to the right and left, and always in opposite directions to each other. In some specimens the upper mandible is turned to the right, the lower mandible curved to the left; in others, the position of the mandibles is reversed as to their direction. In the specimen I examined the upper mandible curved downwards and to the left, the under portion turned upwards and to the right, as the figures 1 and 2, plate xiv, will demonstrate. When holding the head of this bird in my fingers, I found I could bring the point of the under mandible in a line underneath and touching the point of the upper, but not beyond it towards the left side, while on its own side the point passed with ease to the distance of $\frac{3}{8}$ of an inch. The upper mandible has a limited degree of motion on the cranium, the superior maxillary and nasal bones being united to the frontal by flexible bony laminae.

The form as well as the magnitude of the processes of some of the bones of the head are also peculiar to this bird.

The pterygoid processes of the palatine bones are considerably elongated downwards, as shewn at figure 3, letter *a*, to afford space for the insertion of large pterygoid muscles. The os omoideum on each side (figure 3, letter *b*,) is strongly articulated to the os quadratum, (figure 3,

letter *c*,) affording firm support to the moveable portion of the upper mandible. Letters *d. d.* figure 3, refer to the jugal bone, which, united to the superior maxillary bone in front, is firmly attached by its posterior extremity to the outer side of the os quadratum; when, therefore, the os quadratum is pulled upwards and forwards by its own peculiar muscles, to be hereafter mentioned, the jugal bone on each side by its pressure forwards elevates the upper mandible.

The inferior projecting process of the os quadratum, to which the lower jaw is articulated, in most other birds is somewhat linear from before backwards, and compressed at the sides, admitting vertical motion only upwards and downwards; the same processes in the Crossbill are spherical, as shewn at *c.* figure 3; the cavity in the lower jaw destined to receive this process is a hollow circular cup (figure 5, letter *a*); the union of these two portions therefore forms an articulation possessing the universal motion and flexibility of the mechanical ball and socket joint.

The lower jaw is of great strength, the sides or plates elevated, with prominent coronoid processes, (figure 5, *b. b.*,) to which, as well as to the whole outer side of the plates, the temporal muscle is attached, and in a head of this bird which had been divested of all the soft parts, I found on sliding the lower jaw laterally upon the upper as performed by the bird, that before the coronoid process is brought into contact with the pterygoid on its own side, the extreme points of the mandibles were separated laterally to the extent I have already mentioned of $\frac{3}{8}$ of an inch.

The temporal and pyramidal muscles on the right side of the head, that being the side to which the lower jaw inclined, were considerably larger than those on the left, as represented in figures 1, 2 and 4, letters *a.* and *b.*, and indicated by their bulk the great lateral power this bird is capable of exerting to be hereafter noticed. The unusually large size of the pterygoid muscles on each side was very conspicuous, (figure 2, letters *c. c.*,) the space for them being obtained by the great distance to which the articulated extremities of the lower jaw were removed, and the food of the bird being small seeds rendered a narrow pharynx sufficient for the purpose of swallowing.

The muscles depressing the lower mandible are three in number, only one of which, the great pyramidal, is visible, figures 1, 2 and 4, letter *b.*

This strong muscle covers two other small ones, the triangular and square muscles, so called from their particular shape. These three muscles, all of which have their origin on the occipital portion of the cranium, are inserted by strong tendons on the under and back part of each extremity of the lower jaw behind the centre of motion, and consequently by their simultaneous contraction raise the point to which they are attached, and depress the anterior part of the mandible. The lower portions of the ossa quadrata are pushed somewhat forwards by this compression, assisted by two small muscles not exhibited, but the situation of which may be explained by a reference to figure 3. One of these, a small flat muscle, arises from the septum of the orbits behind the small aperture observed in the septum, and passes downwards to be inserted upon the projecting styloid process of the os quadratum; the second is a small pyramidal shaped muscle arising also from the septum, anterior to the other muscle, and passing downwards and backwards is inserted upon the omoideum, both by their contraction pulling the os quadratum forwards and thus elevating the other mandible. The depressors of the lower jaw, and the elevators of the upper, therefore act together to separate the mandibles.

To close the mandibles the temporal and pterygoid muscles elevate the lower jaw, assisted by the slender slips marked *d. d.* figure 2, which extending forwards to the superior maxillary bones, act in concert by bringing them down.

When the lateral motion is required, the great pyramidal muscle on the right side pulls the extremity of the lower jaw to which it is attached backwards, the pterygoid muscles of the left side at the same time powerfully assisting by carrying that side of the lower jaw inwards.

Having thus described the muscles of the mandibles in birds generally, and their peculiar mode of action in the Crossbill, I shall quote Mr. Townson's description of the manner in which they are made subservient to the use of the bird in feeding. "The great pine forests, such as the Hartz in Germany, are the natural places of residence of the Crossbeaks, and the seed of the cones of these trees their food, and it is to pull out the seeds from between the squamæ, or scales of the cones, that this structure is given them. Their mode of operation is thus: they first fix themselves across the cone, then bring the points of the maxillæ from their crossed or lateral position, to be immediately over each other. In this reduced compass, they insinuate their beaks

“ between the scales, and then opening them, not in the usual manner,
“ but by drawing the inferior maxilla sideways, force open the scales
“ or squamæ.

At this stage of the proceeding the aid of the tongue becomes necessary, and this organ is no less admirably adapted for the service required. The os hyoides or bone of the tongue has articulated to its anterior extremity an additional portion formed partly of bone with a horny covering, figures 6 and 7, letter *a*. In shape it is narrow, about $\frac{3}{8}$ of an inch in length, and extends forwards and downwards, the sides curved upwards, the distal extremity shaped like a scoop, somewhat pointed, and thin on both edges, the proximal extremity ending in two small processes elongated upwards and backwards above the articulation with the bone of the tongue, each process having inserted upon it a slender muscle, *b*. figures 6 and 7, extending backwards to the glottis and attached to the os hyoides, which muscles by their contraction extend and raise the scoop-like point. Underneath the articulation of this horny and grooved appendage is another small muscle, *c*. figure 7, which is attached at one extremity to the os hyoides, at the other to the moveable piece, and by its action, as an antagonist to the upper muscles, bends the point downwards and backwards; while, therefore, the points of the beak press the shell from the body of the cone, the tongue brought forward by its own muscle (genio-hyoideus) is enabled, by the additional muscles described, to direct and insert its cutting scoop underneath the seed, and the food thus dislodged is transferred to the mouth; and it will be seen by a reference to the first figure, that when the mandibles are separated laterally in this operation the bird has an uninterrupted view of the seed in the cavity, with the eye on that side to which the under mandible is curved.

“ The degree of the lateral power of these birds,” says Mr. Townson,
“ is surprising, and they are fond of exercising it for mere amusement;
“ they are therefore not a little mischievous.

“ My pets would often come to my table, whilst I was writing, and
“ carry off my pencils, little chip boxes in which I occasionally kept
“ insects, and other similar objects, and tear them to pieces in a minute.
“ Their mode of operation is by first pecking a little hole, in this they
“ insert their bill, and then split or tear the object by the lateral force.
“ When I treated them, as I often did, with almonds in their shells, they

“ got at the kernel in the same manner ; first pecking a hole in the shell, “ and then enlarging it by wrenching off pieces by the lateral power.”

Notwithstanding M. Buffon's assertion to the contrary, they can pick up and eat the smallest seeds, and they shell or husk hemp and similar seeds like other birds; so well contrived and useful is this singular beak. My friend Mr. Morgan kept a pair of these birds for some time, and had opportunities for observing their curious habits. They were impatient under confinement, and restless, climbing over the wires of their cage by the use of their beak and claws like parrots. One of their principal occupations was twisting out the ends of the wires of their prison, which they accomplished with equal ease and dexterity. A short flat-headed nail that confined some strong net-work was a favorite object upon which they tried their strength; and the male, who was usually pioneer in every new exploit, succeeded, by long continued efforts, in drawing this nail out of the wood, though not without breaking off the point of his beak in the experiment. Their unceasing destruction of cages at length brought upon them sentence of banishment. During the period of their captivity a complete change took place in the colour of their plumage without the shedding of a single feather.

The remarks of Buffon on the beak of this bird, which he characterizes as “ an error and defect of Nature, and a useless deformity,” exhibit, to say the least of them, an erroneous and hasty conclusion, unworthy the spirit of the science he cultivated. During a series of observations on the habits and structure of British birds, I have never met with a more interesting or beautiful example of the adaptation of means to an end, than is to be found in the tongue, the beak and its muscles in the Crossbill.

Explanation of the Plate.

- Fig. 1. Head of the Crossbill; side view. *a.* temporal muscle; *b.* great pyramidal muscle.
2. Head viewed from below. *b.* great pyramidal muscle; *c. c.* pterygoid muscles; *d. d.* graciles muscles.
3. Head viewed from the side; *a.* pterygoid process; *b.* os omoideum; *c.* os quadratum; *d. d.* os jugale.

4. Head viewed from behind; *a.* right temporal muscle; *b.* great pyramidal muscle.
 5. Lower jaw, side view; *a.* cavity for articulation; *b. b.* coronoid processes.
 6. Tongue seen from above; *a.* horny scoop; *b. b.* extensor muscles.
 7. Tongue, side view; *a.* horny scoop; *b.* extensor muscles; *c.* flexor muscle.
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ART. LVIII. *Remarks on some English Fishes, with Notices of three Species, new to the British Fauna.* By WILLIAM YARRELL, Esq., F.L.S., &c.

THE season for Whitebait fishing having expired soon after the sending my former remarks on that subject for insertion in the XIVth Number of the Zoological Journal, I waited with some anxiety for the period when nets of small meshes might legally be worked at the mouth of the Thames for Smelts and Sprats, in the hope of obtaining further evidence of the distinction between Whitebait and Shads; and in this expectation I was not disappointed. I obtained, but in small numbers only, both adult Whitebait in roe, and some young ones; but it appeared that the large shoals of this fish, like all those which visit the fresh water for the purpose of depositing their spawn, had, with their fry of the year, quitted the river and returned to the deep. As late as the month of November I obtained several small Shads, only $2\frac{1}{2}$ inches in length, which illustrated another point in the history of that fish. We are told by Baron Cuvier and M. Valenciennes, in the second volume of their work on the Natural History of Fishes (p. 25) that a Perch of 7 inches is in his third year; and I therefore felt convinced that these young Shads, only $2\frac{1}{2}$ inches in length when taken in November, were in reality young fishes of the same year, and that the young Shads of 4 inches in length, obtained in the months of July and August preceding, were the young fishes of the year before, the greater part of them having arrived at the length of 4 inches

at or very soon after the time the adult fishes had shed their ova. There was also this obvious and invariable distinction between young Shads and Whitebait: the latter never exhibited any trace of the spots on the sides so conspicuous in the Shads. The Shads, on the contrary, were never without some indication of these peculiar spots, though their number and intensity of colour appeared to depend on the strength and condition of the fish. The first spot immediately behind the operculum however is never wanting; some of the young Shads taken in July and August exhibited as many as five spots, of which the specimen figured was an example, but the youngest as well as the weakest invariably possess one spot behind the upper part of the edge of the operculum; even the young Shads of $2\frac{1}{2}$ inches only, taken in November, the smallest I have been able to procure, have this distinction, and in this state most resemble Whitebait; but I may add in conclusion, as an invariable point of distinction between the two fishes, that I have never seen a Whitebait of any age or size with this spot, or a Shad without it.

On shewing a series of specimens of these two fishes to M. Valenciennes during his late visit to London, that gentleman, who has made this branch of Natural History his particular study, stated that he considered them decidedly different.

In proposing the term *alba* as a specific distinction for the Whitebait, in a former paper, I by no means intended to be understood as supposing that this fish had remained as yet undescribed by Continental Naturalists, I only desired to claim for this distinct species an appropriate appellation in our list of British Fishes. It may be “Le Prêtre ou Spret de Calais, le Franc-Blaquet ou Franche Blanche,” four names given by Duhamel to one small species of *Clupea*, though his figure is not like our fish; yet as the Whitebait frequents the Thames every summer, it is not unlikely that it should be taken at Calais.

Sir Everard Home, in his recently published additional volumes on Comparative Anatomy (Vol. V. c. 4, sect. 1, page 232 and Vol. VI. plate 28) has inferred, from certain resemblances in the ova and serrated abdominal edges of four fishes of the genus *Clupea*, that the Whitebait is a young Shad, and the Sprat a young Herring. Dr. Fleming, in his History of British animals, published in 1828, does not allow the Sprat a place among his fishes, and at page 183, after giving the specific cha-

racters of the Pilchard (*Clupea Pilcardus*,) the following sentences occur:
 “ The fry of the Herring and Pilchard are confounded together under the
 “ epithet *Sprat*. The position of the dorsal fin, in reference to gravity,
 “ furnishes, however, an obvious mark of distinction.” The differences
 already detailed as existing in the anatomy and habits of Whitebait and
 Shads render any further observations on that subject unnecessary, while
 between the Sprat and Herring the distinctions are still more decided.
 On comparing a Sprat with a young Herring of the same length, at
 which age they are called by the fishermen Yawlings, the Sprat will be
 found to be considerably deeper, and the scales much larger; in this lat-
 ter circumstance the Sprat resembles the Pilchard, but the Pilchard on
 the other hand is not so deep a fish as the Herring. The Sprat and Her-
 ring differ also in the number of rays in three of their fins out of the four
 they possess, and also in the tail, as the following numbers exhibit.

	D.	P.	V.	A.	C.
Sprat	17	15	7	18	19
Herring : . . .	17	14	9	14	20

There is also one other most material difference, the vertebræ in the
 Sprat are 48 in number, in the Herring there are 56, as I have ascer-
 tained upon many examples of both species.

The number of vertebræ in the Whitebait and Herring being the same
 might suggest the idea that the Whitebait were young Herrings, but the
 economy of the species prevents this conclusion. The Whitebait are un-
 known on the shores of our various Northern Islands, where the Herrings
 in myriads deposit their spawn; and on the other hand, the Thames pro-
 duces Whitebait in abundance during the summer, remaining with us till
 August, when the Herrings are heavy with roe which they do not deposit
 till October.

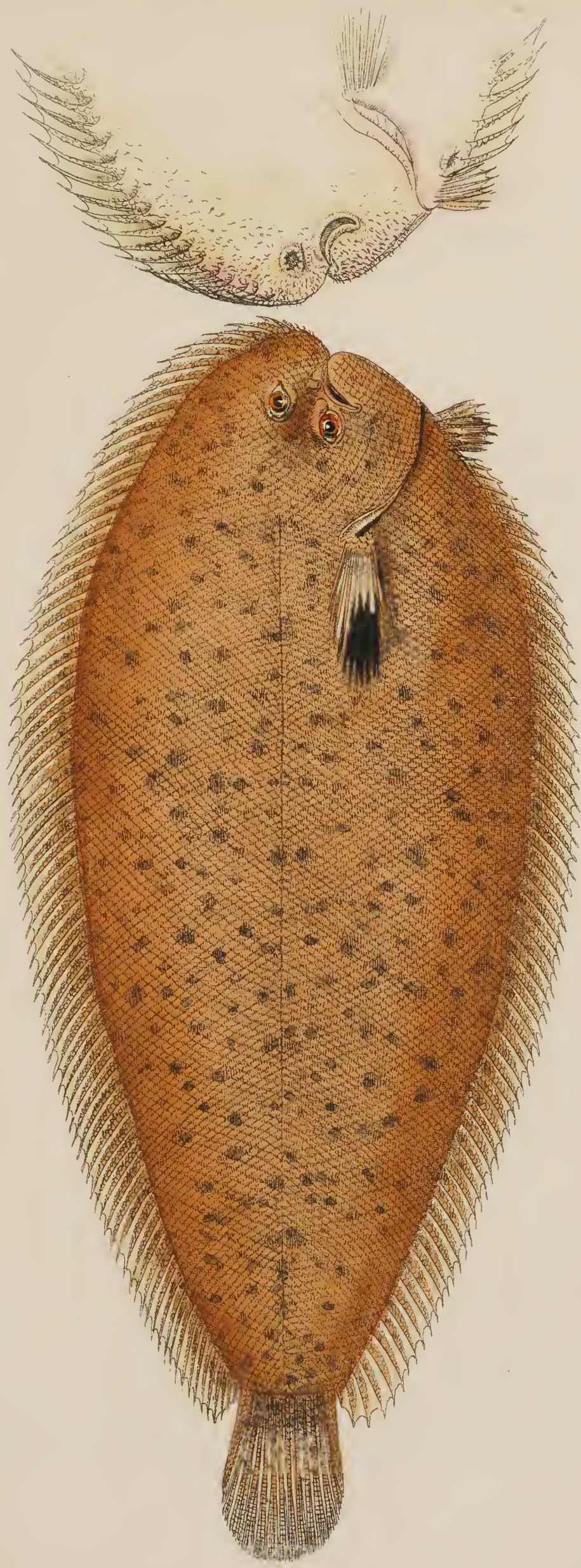
SOLEA PEGUSA.

During a short visit to Brighton the last week of February I
 obtained a single specimen of a Sole which it occurred to me had not
 been admitted into any British Fauna, and further search on my

return home has confirmed that opinion. No description in our various ichthyological works appearing to agree with this species, I venture to consider it as new to our coast, and shall therefore describe it. In shape it is wider in proportion to its whole length than the common Sole (*Solea vulgaris*) and it is also somewhat thicker. The specimen measures from the point of the nose to the end of the tail 8 inches, across the widest part of the body, not including the fins, 3 inches, including both fins, 4 inches. In an example of the common Sole obtained for comparison, the whole length of which was 8 inches and $\frac{3}{8}$, the greatest breadth without the fins was only $2\frac{1}{2}$ inches, with the fins included, $3\frac{1}{2}$. The number of rays in the different fins of the two species were

	D.	P.	V.	A.	C.		
Common Sole. . .	84	7	5	67	17	vertebræ	47
New species. . . .	81	8	5	69	17	,,	43

In its general aspect this new Sole, compared with our common species, is much more round and fleshy, the head obtuse, shorter and wider, the mouth arched, the operculum formed externally of a single piece, circular in shape and less deep, tip of the pectoral fin black, lateral line straight but not very strongly marked, tail narrower than in the common sort though composed of the same number of rays, the prevailing colours a mixture of orange and light brown, freckled over with small circular spots of very dark brown, giving a mottled appearance to the whole upper surface. The scales also differ both in character and general arrangement. On the under side the appearance is still more characteristic of its distinction. The surface of the head is almost smooth, without any of the papillary eminences so remarkable in the common sort, and the nostril is pierced in a prominent tubular projection which is wanting in the other; the under surface white, the appearance of the scales more strongly marked than upon the upper. This species is occasionally taken with the common Sole by trawling over a clear bottom of soft sand, about 16 miles from Brighton. It is but partially known there by the name of Lemon Sole, and the same name is by the fishermen also applied to a species of *Pleuronectes*, which however has no resemblance to this new fish beyond that of its prevailing yellow colour.





It appears to be perfectly distinct from the *Pleuronectes Lingula* of Pennant, which may be considered the *Pleuronectes Linguatula* and *Pleuronecte languette* of Linn., Gmel., and La Cépède, and differs also from the *Pleuronectes variegatus* of Donovan. A short description of *Solea Pegusa* will be found in the *Histoire Naturelle des Poissons* of M. La Cépède, Vol. IV. p. 639; it appears to be a fish of the Mediterranean, and according to M. Noel of Rouen has been taken in the environs of Caen, but considered very rare. It is described shortly by Risso, under the names of Sollo de rocco, *Pleuronecte Pegouse* and *Pleuronectes Pegusa* in his *Ichthyologie de Nice*, p. 308, and is also the *Monochirus Pegusa*, *Monochire Pegouse* and *Solla d'arga* of the same author's *Histoire Naturelle des principales productions de l'Europe Meridionale*, Tom. III. p. 258.

The different writers on British Fishes agree in admitting but one common species of fresh-water Eel, but from recent examinations I am induced to believe there are two, independent of course of the species our markets are largely supplied with from Holland, which appears to be distinct from either. The difference between our two Eels is immediately apparent when they are brought together for comparison, by the very opposite characters of the head, the one being as remarkable for its slender and attenuated form, as the other is robust and blunt. The sharp-headed Eel, which I call it for distinction, appears to be the *Anguilla vulgaris* of authors. In this species the head is angular, depressed, eyes small, placed immediately over the angles of the mouth, irides yellow, both jaws narrow, acute, the lower jaw longest, nostrils with two openings on each side, one tubular, the other a simple pore near the eye, gill opening before and below the pectoral fin, the fin $1\frac{1}{2}$ inch from the point of the nose, dorsal fin occupying $\frac{3}{4}$ of the whole length of the fish, lateral line straight, tail acute. In the second species the head is rounded superiorly and flattened from the eyes forward, both jaws broad and blunt, the lower one the widest, and longer than the upper, the eyes large, placed rather before the gape, irides golden yellow, the gill openings, pectoral fins, commencement of the dorsal fin and the vent placed farther back than in the sharp-headed Eel, pectoral fins larger, tail broad,

dorsal and anal fin much deeper and thicker in substance than in the first species. The two Eels here described were of the same length. The sharp-headed fish measured two inches in girth, and was a male, the blunt-headed species measured $2\frac{5}{8}$ inches, and proved a female; of five others examined as to the sexual organs, two were males and three females, exhibiting distinctly their milt and ova. The figure in Bloch is that of the sharp-headed eel; that in Meyer, plate 42, is a representation of the blunt-headed Eel; both species appear therefore to be known on the continent. I have said nothing of colour in either, believing that it affords no true specific distinction, and may partly depend on the quality of the water from which they have been taken. This species may be the Grig of Pennant, but this is stated to be of small size and less fat than the sharp-headed species. This has not been the case with numbers that I have examined by comparison, which have universally appeared one-fourth larger in circumference, for equal length, and in good condition. A prejudice exists that all fishes with large heads are in bad condition or out of season, which though true in regard to Trout or Salmon, is certainly not founded in fact with respect to Eels.

COTTUS BUBALIS.

During the summer months of last year, when pursuing the investigation of the distinctions between the Whitebait and Shads, I was supplied with three examples of the genus Cottus, taken at the mouth of the Thames, which at that time, more intent on the subject I had in hand, I took no notice of beyond placing them in a preserving liquid, believing them to be specimens of Cottus Scorpius. When favoured lately with a visit from M. Valenciennes, and looking over a small collection of British Fishes together, that gentleman pointed out these specimens as examples of the Cottus Bubalis, and demonstrated the specific differences between Bubalis and Scorpius. The Cottus Bubalis appears to have been noticed by Euphrasen, *Nouv. Mem. de Stockholm*, Vol. VII, plate 4, fig. 2 and 3; it is also noticed in the *Règne Animal* of Baron Cuvier, Vol. II. page 306, note.

The Cottus Bubalis is distinguished by having the head still more powerfully armed than the Father Lasher, and is thus characterised by Schneider, Vol. I. p. 62. “Capite depresso, scabro, spinoso, bicorni, oculis

“ verticalibus, approximatis, linea laterali scabra, tuberculata, radiis 4
 “ pinnarum ventralium.”

This species has not hitherto been admitted in our Fauna, yet I have reason to believe it is very common, and has been constantly confounded with *C. Scorpius*. The fin rays are as follow.

	1st D.	2d D.	P.	V.	A.	C.
<i>Cottus Scorpius</i> .	10	14	17	3	10	12
<i>Bubalis</i> .	8	11	15	3 or 4	9	10

Atherina Hepsetus. The Atherine is taken in great abundance during the spring months within a short distance of Brighton. A fishing-boat's crew under favourable circumstances have been known to take as many as would fill a bushel measure during one tide. They are sold under the name of Sea-smelt and Sand-smelt, from the nature of the bottom over which they are taken; but possess none of the odour, and but little of the flavour, peculiar to the true Smelt. The Atherine is plentiful along the extended line of our Southern coast, but only occasionally makes its appearance in the London Market.

The *Sparus lineatus* of Montagu, described and figured in the Wern. Mem. Vol. II. p. 451, tab. 22, a specimen of which I exhibited a short time since to the Zoological Club, and of which I have since seen a second example, both taken on our coast, proves to be a Mediterranean fish, the *Sparus Sargus* of Bloch, but imperfectly figured. Its characters are given by Schneider, Vol. 1. p. 270. The trivial name *lineatus* proposed by Montagu, and recently adopted by Dr. Fleming, will therefore require to be changed.



